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AIR TRANSPORT DEMAND AND ECONOMIC ACTIVITY IN THE CZECH REPUBLIC

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Summary: The paper deals with often discussed issue of air transport demand. It describes the relationship between air transport demand and economic activity on the case of the Czech Republic. The paper concerns only on main civil airports designated for international traffic and specific macroeconomic values which describes the economic situation of the country. In each case there was found some kind of relationship between transportation performances and economic activity. The relationship was either direct or inverse, with different level of intensity.

Key words: demand, air transport, economic activity

INTRODUCTION

In the field of air transport there are many studies that are trying to find some kind of relationship between air transport demand and some other determinants since air transport demand is important parameter for subjects such as transport planners, airlines, airports and aircraft manufacturers as well. In the past the literature has defined basic determinants of air travel demand. Jorge-Calderón divided these factors into two groups. Factors airlines can´t affect are called geo-economic factors, determined by the economic activity and geographical or specific local conditions of the transportation area. These factors can be further divided into activity and locational factors (1). The most common activity-related indicators are income and population (2), (3). Researchers have proven relationship between air traffic demand and gross domestic product (4), (5), (6). Victor Valdes also confirmed gross domestic product per capita as other determinant (3). Total consumption expenditure is the last of activity factors that authors included in this group of determinants (2), (7). The most common locational factor is distance (1), (8), (9), (10). Second group of factors includes service-related factors, determined by quality and price of the service that passengers have to pay. These determinants are completely given by the airline. Many studies have confirmed three following determinants in this group: frequency of departures, load factor and aircraft size or technology (1), (10), (11).

1. METHODS AND DATA

This part of the paper describes methods and data that were used to find out the relationship between air transport demand and selected economic factors.

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1.1 Used methods

Many studies have demonstrated the relationship between the economic factors in the researched area and air transport demand. For the verification of the theory that economic factors have influence on air transport demand is used correlation analysis in this paper since it allows finding and validating the relationship between various indicators. To confirm the real relationship of determinants is necessary to do the correlation analysis of residues. Residues can be calculated in various ways, for instance by exponential smoothing, given by the following equation (12):

$$Y_{n-k} = (1-\alpha) \times y_{n-k} + \alpha \times Y_{n-k-1} \tag{1}$$

where:

α … equalization constant

n … time point representing the observation in the present tense

k … age of observations from the view point of time n

After the residues are calculated it is necessary to approve its independence by the Durbin-Watson autocorrelation test and its random arrangement by the Sign test or Turning point test. After verifying the independence and random assortment of residues the correlation can be made to confirm or disprove a real correlation between the time series.

To measure the tightness of dependence between variables is used correlation coefficient:

$$r_{12} = \frac{\sum x_{1i} x_{2i} - \sum x_{1i} \sum x_{2i}}{\sqrt{[n \sum x_{1i}^2 - (\sum x_{1i})^2] \times [n \sum x_{2i}^2 - (\sum x_{2i})^2]}} \tag{2}$$

where:

n…number of pairs of data

x_1, x_2 … examined variables

The last step is to do hypothesis testing of the correlation coefficient, because high value of the correlation coefficient does not automatically imply a causal relationship between the variables. The test statistic is:

$$t = \frac{r_{yx}}{\sqrt{1 - r_{yx}^2}} \times \sqrt{n-2} \tag{3}$$

where:

r_{yx} … correlation coefficient

n…number of pairs of data

1.2 Airports in the Czech Republic

For the purposes of the article we will consider only five out of ninety airports in the Czech Republic. These airports are the biggest airports in the country and they are also only

civil airports designated for international traffic in the Czech Republic. The following map shows the location of the examined airports.

Fig.1 - Airports selected for examination

1.3 Macroeconomic factors

In the introduction were mentioned basic factors that provably have influence on air transport demand. For the purposes of the article were chosen similar factors: population, gross domestic product, total consumption expenditure and also number of unemployed citizens and average nominal wage. After the independence of residues and its random arrangement was proven it was possible to use only three out of these five factors for further calculations. These factors are population, gross domestic product and number of unemployed citizens.

2. MODELING OF RELATIONSHIPS AMONG SELECTED FACTORS

The influence of macroeconomic factors was gradually examined on the number of passengers, the amount of handled cargo and number of aircraft movements.

2.1 Passengers

After the residues were calculated by the exponential smoothing in was possible to calculate the correlation coefficients of residues, given by the following correlation matrix.

	Praha	Ostrava	Pardubice	K. Vary	Brno	Population	GDP
Ostrava	0,73	...	...	...	...	...	...
Pardubice	−0,19	0,13	...	...	...	...	...
K. Vary	−0,18	−0,13	0,49	...	...	...	...
Brno	0,59	0,54	0,05	0,56	...	...	...
Population	0,49	0,42	−0,06	0,19	0,39	...	...
GDP	0,79	0,82	−0,05	−0,16	0,50	0,16	...
Unemployed	−0,69	−0,73	0,13	−0,04	−0,50	−0,70	−0,63

Fig. 2 Correlation matrix of passengers

Next step was to do hypothesis testing of the correlation coefficient mentioned in figure 2 by the test statistic.

	Praha	Ostrava	Pardubice	K. Vary	Brno	Population	GDP
Ostrava	3,03	...	...	...	...	...	...
Pardubice	−0,56	0,36	...	...	...	...	...
K. Vary	−0,51	−0,37	1,60	...	...	...	...
Brno	2,04	1,80	0,15	1,91	...	...	...
Population	1,58	1,32	−0,18	0,53	1,20	...	...
GDP	3,70	4,10	−0,14	−0,47	1,62	0,47	...
Unemployed	−2,71	−3,06	0,37	−0,11	−1,62	−2,77	−2,32

Fig. 3 – Matrix of test statistic of number of passengers

The critical value is given by the formula $|t| > t_{1-\alpha/2}$. The critical value looked up in the statistical tables is 2,306 for all calculations. If the value of the test statistic is outside the critical area (-2,306; 2,306) the dependence of the considered factors is confirmed.

According to the Figure 3 is proven direct proportion between following factors:

- number of passengers in Prague and Ostrava,
- number of passengers in Prague and gross domestic product,
- number of passengers in Ostrava and gross domestic product.

The strongest direct proportion was revealed between number of passengers at Ostrava airport and gross domestic product. To illustrate the relationship might be used following figure.

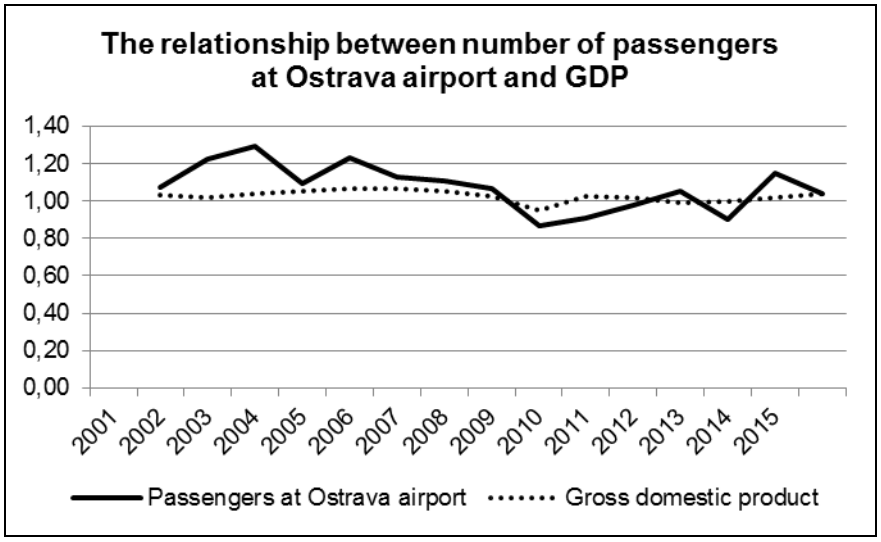

Fig. 4 The relationship between number of passengers at Ostrava airport and GDP

From figure 4 is obvious that growth rates of these factors differs due to inaccuracy of the model. The value of reliability of the model that describes the relationship between number of passengers at Ostrava airport and gross domestic product, expressed by the coefficient of determination is only 36,58 %, which means that the model doesn´t describe data correctly enough and will not be used for further calculations.

According to the Figure 3 is also proven inverse proportion between following factors:

- number of passengers in Prague and number of unemployed citizens,
- number of passengers in Ostrava and number of unemployed citizens.

The strongest inverse proportion was revealed between number of passengers at Ostrava airport and unemployed citizens. To illustrate the relationship might be used following figure.

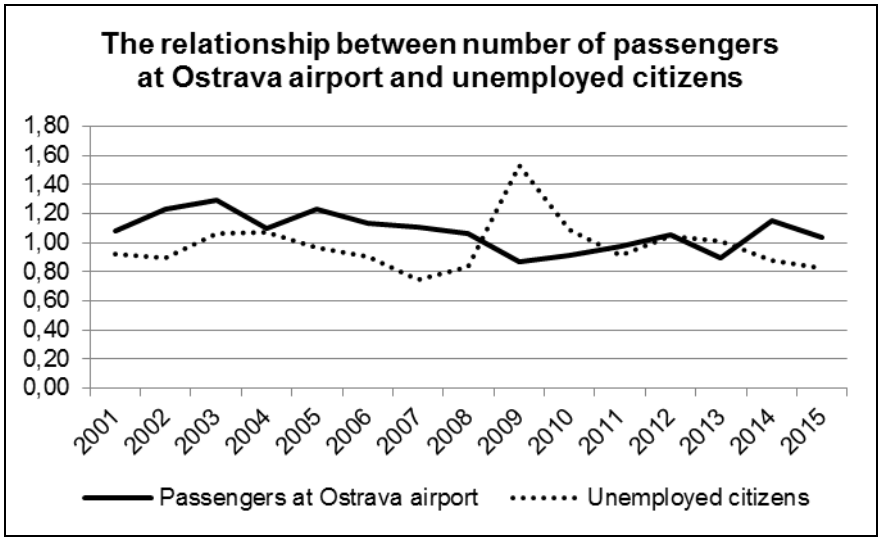

Fig. 5 The relationship between number of passengers at Ostrava airport and unemployed citizens

From figure 5 is quite obvious inverse proportion of chosen factors and also inaccuracy of the model. The value of reliability is even lower than in was in a previous case, this time it is only 18,60 %, so model will not be used for further calculations.

2.2 Cargo

The calculation of relationship between amount of handled cargo and other selected factors is the same as in the previous case. The values of correlation coefficients are written in the following correlation matrix.

	Praha	Ostrava	Brno	Population	GDP
Ostrava	−0,53	...	...	...	...
Brno	−0,29	−0,53	...	...	...
Population	−0,16	−0,50	0,67	...	...
GDP	0,59	−0,16	−0,41	0,16	...
Unemployed	−0,01	0,35	−0,17	−0,70	−0,63

Fig. 6 Correlation matrix of amount of handled cargo

Results of the hypothesis testing of the correlation coefficient mentioned in figure 6 are written in the following figure.

	Praha	Ostrava	Brno	Population	GDP
Ostrava	−1,76	...	...	...	...
Brno	−0,86	−1,75	...	...	...
Population	−0,47	−1,62	2,52	...	...
GDP	2,06	−0,46	−1,28	0,47	...
Unemployed	−0,03	1,06	−0,47	−2,77	−2,32

Fig. 7 – Matrix of test statistic of amount of handled cargo

According to the Figure 7 was proven only direct proportion between amount of handled cargo at Brno airport and the population in the Czech Republic. The relationship is graphically described in the following figure.

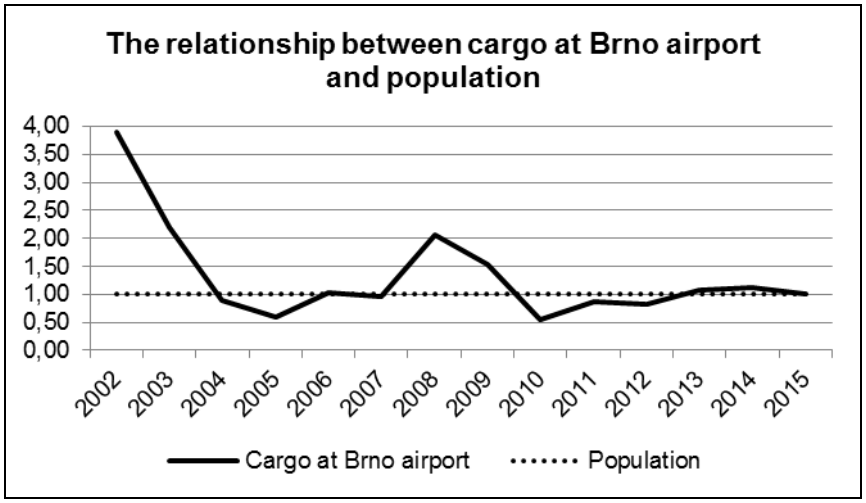

Fig. 8 The relationship between cargo at Brno airport and population

According to the figure 8 is obvious considerable inaccuracy of the model and it is not surprise that value of reliability is only 1,58 %. Model will not be used for further calculations as well.

2.3 Aircraft movements

Aircraft movement includes total number of landings and takes off at selected airport. The calculation is the same as in the previous cases.

	Praha	Ostrava	Pardubice	K. Vary	Brno	Population	GDP
Ostrava	0,73	...	...	...	...	...	...
Pardubice	−0,10	−0,36	...	...	...	...	...
K. Vary	−0,02	−0,29	−0,34	...	...	...	...
Brno	0,45	0,73	−0,43	−0,01	...	...	...
Population	0,40	0,21	−0,23	0,35	0,65	...	...
GDP	0,89	0,66	−0,04	−0,12	0,31	0,16	...
Unemployed	−0,75	−0,65	0,19	−0,09	−0,78	−0,70	−0,63

Fig. 9 Correlation matrix of number of aircraft movements

Hypothesis testing of the correlation coefficients mentioned in figure 9 is given by the following figure.

	Praha	Ostrava	Pardubice	K. Vary	Brno	Population	GDP
Ostrava	3,01	...	...	...	...	...	...
Pardubice	−0,28	−1,09	...	...	...	...	...
K. Vary	−0,05	−0,86	−1,03	...	...	...	...
Brno	1,42	3,04	−1,33	−0,01	...	...	...
Population	1,24	0,60	−0,65	1,05	2,42	...	...
GDP	5,50	2,46	−0,11	−0,35	0,92	0,47	...
Unemployed	−3,24	−2,39	0,56	−0,27	−3,55	−2,77	−2,32

Fig. 10 – Matrix of *test statistic of* number of aircraft movements

According to the Figure 10 is proven direct proportion between following factors:

- number of aircraft movements in Prague and Ostrava,
- number of aircraft movements in Prague and gross domestic product,
- number of aircraft movements in Ostrava and Brno,
- number of aircraft movements in Ostrava and gross domestic product,
- number of aircraft movements in Brno and population.

The strongest direct proportion was revealed between number of aircraft movements at Prague airport and gross domestic product. To illustrate the relationship might be used following figure.

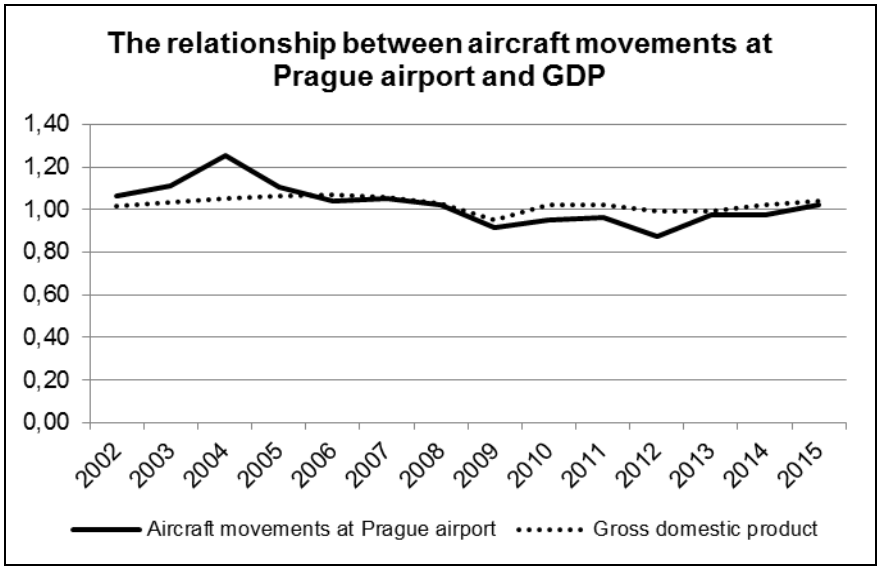

Fig. 11 - The relationship between number of aircraft movements at Prague airport and GDP

Figure 11 represents the most reliable model so far, with value of reliability 44,16 %. Even if there is low reliability, the model was by the test statistic F proven to be statistically significant because value of test statistic F= 9,49 is outside of interval of deny which is (-6,414;6,414).

According to the Figure 10 is also proven inverse proportion between following factors:

- number of aircraft movements in Prague and number of unemployed citizens,
- number of aircraft movements in Ostrava and number of unemployed citizens,
- number of aircraft movements in Brno and number of unemployed citizens.

Finally, the last model was created to describe the strongest inverse proportion. Following figure describes the relationship between aircraft movements at Brno airport and unemployed citizens.

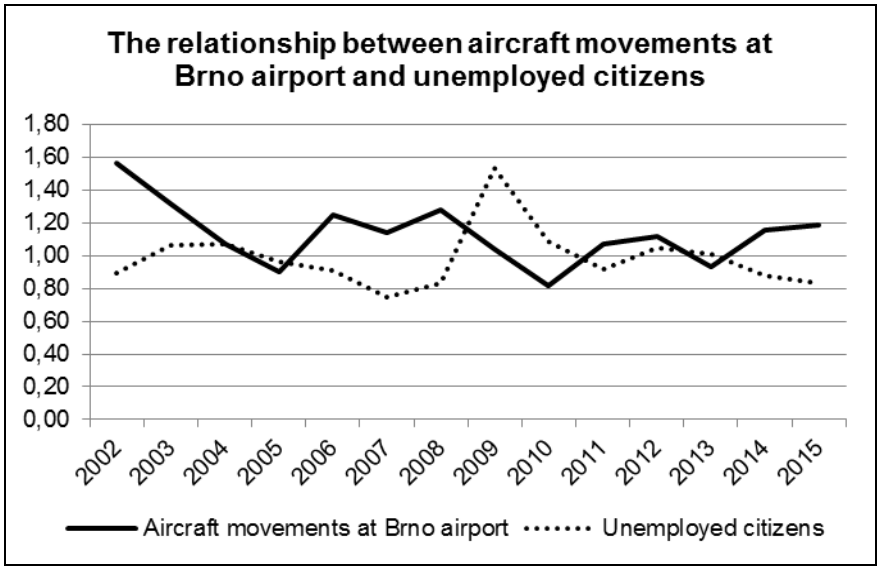

Fig. 11 - The relationship between aircraft movements at Brno airport and unemployed citizens

Figure 11 describes inverse proportion between factors. Since the coefficient of reliability is only 10,68 % the model will not be used anymore.

CONCLUSION

The article deals with issue of air transport demand which is quite discussed issue. Based on the previous researches, which proven relationship between air transport demand and macroeconomic factors were chosen similar factors for the purposes of the paper, with the goal to accept or deny the relationship on the case of the Czech Republic. The calculations proved the existence of direct or inverse relationship between various factors with different intensity level of the relationship. Thus the result is a confirmation of the fact, that relationship really exists between air transport demand and the economic activity represented by macroeconomic factors in the Czech Republic. Even if relationships were proven, it is a pity that reliability of dependence models is so low. Future research might try to find factors influencing air travel demand with higher level of reliability, so the models could be used further, for example for prediction of transportation performances thanks to the public knowledge of macroeconomic factors predictions.

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